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BIRTH TO SLAUGHTER INFORMATION SYSTEMS AND RETAINED OWNERSHIP STRATEGIES FOR SASKATCHEWAN COW/CALF PRODUCERS

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Birth to Slaughter Information Systems and Retained Ownership Strategies for Saskatchewan Cow/Calf Operators

ADF Project # 97000102

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Final Report

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Executive Summary:

The objective of this project was to work with a select group of producers across Alberta and Saskatchewan to develop a birth to slaughter information system that incorporates both financial and production data at each stage of the production cycle. The intent is to be able to use this system to make informed decisions regarding the cow/calf enterprise, particularly in light of recent innovations in the beef industry such as retained ownership programs, grid marketing and branded beef.

The project has been undertaken in conjunction with the Information Management Systems project at the Western Beef Development Centre as per the memo of Dr. John McKinnon to Dr. Javed dated March 16, 1998 with milestones set as per Dr. Javed's letter of December 18, 1998. The Information Management Systems project involved working with cow-calf producers across Alberta and Saskatchewan over a 3 year period. In years 1 and 2, approximately 30 producers were involved. In year 3, 20 producers were enrolled. This project was designed to allow for a two-way information transfer from the cow-calf producer to the feedlot to the packing plant and back. By so doing, it allowed for tracking from pasture to plate on individual animals and facilitation of sound management practices that target safe and wholesome beef. In designated cases, knowledge of breeding history and carcass quality for each individual calf helped identify breeding programs which may produce known and desired beef carcass quality (high lean meat yield, AAA marbling). Information on the overall project can be derived from the Western Beef Development Centre's final report to the Agri-Food Innovation Fund (#97000446).

The project reported herein represents an analysis of a subset of the data collected in the IMS project and represents the work of Sandy Russell, a graduate student in the Department of Animal and Poultry Science. Three trials were undertaken. In trial 1, a selected group of ten producers enrolled in the Information Management Systems project at the Western Beef Development Centre were used to collect herd production and financial information from birth to slaughter and to determine the within and between herd variability for key production and economic parameters. The data was based on the 1998 and 1999 calf crops. Correlation and regression analysis was used to determine the degree of association that exists between production parameters in different segments of the production chain. The results indicate that a large degree of variation exists both within and between cow/calf enterprises in western Canada in terms of production and economic parameters throughout the beef production chain. Production measures such as weaning weight, age at wean, days on feed, final weight and hot carcass weight varied greatly within and between herds. This variability illustrates that there is tremendous opportunity for improvement in these significant end measures of production in western Canadian cow/calf enterprises.

In trial 2, 19 producers who had participated in the Whole Farm Cost of Production Program run by the Western Beef Development Centre and Saskatchewan Agriculture and Food were used to rank cooperating cow/calf enterprises over a two year period (1998 and 1999 calf crops) according to the profitability of the operation and to examine

differences between high and low profit operations in terms of key production and financial parameters. The results indicate that financial parameters are the key factors influencing the profitability of the cow/calf enterprise. Production parameters did not differ between groups when enterprises are ranked according to profitability. However, variable costs, specifically unpaid labour and winter feed costs, along with value of production were the key differences between the low and high profit groups. This suggests that the producers involved in this project had achieved a relatively high standard of production. However, the variability in profit between enterprises begins to exist when cost and value of production are considered.

Trial 3 examined the need for technology associated with tracking animals from birth to slaughter. The trial utilized the Allflex™ RFID and the Destron Fearing™ RFID systems in an attempt to determine the success rate of these systems within the feedlot and slaughter plant sectors. Both systems exhibited a high degree of reliability and accuracy and can be recommended for use in birth to slaughter information programs, particularly as competitive pricing continues to reduce initial output costs.

Finally, through the work of Sonja Lemm and Naomi Smith, of the Western Beef Development Centre, we have been able to tie in the activities of our project with the activities of:

- two retained ownership projects run in conjunction with Saskatchewan Agriculture (Punichey Group and Wawota ADD Board Retained Ownership Project);
- with the identification initiatives of Kathy Martin of Saskatchewan Agriculture and Food and Western Canadian Beef Packers;
- and the National Identification Program of the Canadian Cattlemen's Association.

It was concluded that as the beef industry moves closer to value-based marketing systems, knowledge of the within and between herd variability in key production and financial traits will help producers target specific markets through informed breeding and management programs. Financial considerations need to be carefully considered before production decisions are finalized.

I. Introduction:

Consumer concerns regarding food safety, quality and consistency have resulted in a decline in beef consumption over the last two decades. The challenge to the beef industry is to respond to consumer concerns and provide a safe, quality product that regains the consumer's trust. In order to address these consumer concerns and recapture some of this lost market share the beef industry has begun to support and promote various management tools such as retained ownership, value-based marketing, branded beef products and industry alliances.

Communication between the various segments of the production chain has been limited in the past and is partially responsible for the inconsistency of beef products. The development of industry alliances and value-based marketing systems encourages sharing of information and communication. This increase in communication between segments of the industry will lead to improved quality and consistency of beef products. With increased importance placed on cow/calf producers understanding the carcass merits of the herd, it is essential that producers monitor the performance of their animals throughout the entire production chain. As the industry continues to improve information transfer, cow/calf producers will be under increasing pressure to provide production information on their animals to the various segments of the industry. Knowledge of within and between herd variability for important production traits from birth to slaughter including carcass quality and their relationship is a key first step in order for producers to make changes that would increase profitability under modern beef marketing strategies.

In addition, balancing both production and financial management is becoming increasingly important as cow/calf producers strive to achieve and maintain profitability under fluctuating market prices and narrow profit margins. Historically, producers have monitored production factors in order to remain competitive, however, maximizing production does not always result in high profits. Cost of production appears to be one of the major determinants of profitability. Therefore, it is essential that producers closely monitor and control their production cost. Complete enterprise analysis is one of the most useful management tools for identifying areas for production and financial improvement. The analysis allows producers to measure and monitor production and financial factors that are influencing the herd. As the beef industry continues to progress, financial and production evaluation will be essential for cow/calf producers to remain profitable. This information can also be valuable when collected across the industry for benchmarking purposes and for use as an extension tool. If benchmark averages are available, producers can use these to compare their averages for production and profit to the average of the industry.

Individual identification has been the logical approach to assuring consumer confidence. Safe, consistent and quality beef can be ensured when animals are traced throughout the entire production chain. In order for producers to take full advantage of the opportunities of information management programs, it is essential that each animal be identified utilizing a quick and efficient system that can easily transfer information between all sectors involved in beef production. Radio frequency identification ear tags

can potentially offer the technology needed in order to trace animals throughout the production cycle.

Many opportunities are available to producers through the use of programs such as retained ownership, branded beef and industry alliances. However, producers need to be aware of the added risks along with the benefits when using these programs. These programs pay according to the quality of their animals and if ranchers are not aware of how their animals perform throughout the entire production chain major losses can be incurred. A benefit of many of these programs is that it provides producers with information on animal performance beyond weaning. It is therefore important that producers be able to use this information to improve quality and consistency of the animals they produce if they are to benefit from these programs.

The objectives of this study were to:

1) To develop a birth to slaughter information system based on electronic identification that facilitates collection and transfer of health, performance and management data on individual calves.

2) To use the data collected from this system to determine:
   a. the within and between herd variability for key production and economic parameters from birth to slaughter.

   b. the relationship between production and financial parameters that exist throughout the beef production chain.

3) Identify the differences between high and low profit operations in terms of key production and financial parameters and determine what production parameters influence the profitability of a cow/calf enterprise in western Canada.

4) Determine the retention rate of two radio frequency identification tag systems and the accuracy with which ear tags are read both in a feedlot and packing plant setting.

Study Area 1
Analysis of Production and Economic Factors that Influence Animal Value and Profitability

Introduction

Recent changes within the beef industry have resulted in increased interest in the development of birth to slaughter information collection systems. The introduction of programs that require specific carcass quality information, programs that produce branded products, grid pricing systems and retained ownership have all led to this increased interest. These programs require that individual production data be collected from birth through to slaughter in an attempt to improve overall herd management and therefore profitability.

Cattle producers cannot improve their herd management if they do not have a measure of their production. Throughout the production cycle important production parameters can be used as indicators of profitability. These parameters include: calving rate, weaning weight, slaughter weight and carcass hot weight.

By collecting individual animal data, producers can have a better understanding of the success of their enterprise. Alone, production data only provides the producer with an estimate of the success of his animal management practices. The value of production data, however, can be greatly increased when used in conjunction with the financial data from that enterprise. The Information Management Systems project at the Western Beef Development Centre was developed to help producers capitalize on changes in the way beef cattle are marketed. The project provides producers with information regarding the entire production process. This includes production and financial measures on: birth to weaning, weaning to finish, and carcass quality.

In addition to assisting producers with collection and compiling of the data, it is necessary that producers be able to interpret the data such that they can make sound economic and management decisions. In order to do this, it is necessary that information collected throughout the production process be analyzed to determine which production factors are having the greatest influence on animal value and profitability. For example, in order to make changes, beef producers must know not only which factors influence animal value and profitability but they must also know the within and between herd variability that exists for these key production and economic parameters. It is also important to understand the relationships between traits collected from birth to weaning with feedlot or carcass quality traits. For example, will selection emphasis on marbling scores adversely effect feedlot average daily gain, slaughter weights or carcass parameters such as weight or yield grade. Answers to such questions will be important if birth to slaughter information systems are to become established and utilized by producers.

Objective

The objective of this study was to work with a selected group of producers enrolled in the Information Management Systems project at the Western Beef Development Centre to collect herd production and financial information from birth to slaughter and to determine the within and between herd variability for key production and

economic parameters. Correlation and regression analysis will be used to determine the degree of association that exists between production parameters in different segments of the production chain.

Methodology

Ten producers from across Saskatchewan and Alberta were selected from a larger group of producers who have been involved in the Western Beef Development Centre's Information Management Program since 1998. The selection was based on the ability of the producer to provide complete and accurate individual animal information throughout the production cycle including carcass information.

Production information was collected for each herd from birth through to slaughter for the 1998 and 1999 calf crops. Once collected the production parameters were divided into three sections:

1. Birth to Wean
    - Calf identification, sex, birth date, birth weight, weaning weight, age at weaning and 205 day adjusted wean weight
2. Wean to Finish
    - Days on feed, average daily gain, final weight and 400 day adjusted final weight
3. Carcass Quality
    - Slaughter date, age at slaughter, hot carcass weight, carcass quality grade and carcass yield grade

Financial information was also collected for each herd from birth through to slaughter for the two production years. This information was collected in conjunction with the cost of production project of the Western Beef Development Centre and Sask. Ag and Food. As with the production data, the financial parameters were divided into three sections:

1. Birth to Wean
    - Weaning cost of production (i.e. cost per pound of gain determined by total variable and capital costs for the cow-calf enterprise), value at weaning and weaning profit
2. Wean to Finish
    - Feeding cost of gain (i.e. cost per pound of gain determined by value charged by feedlot or the total variable and capital costs for the feeding enterprise), value at the time of finish and feeding profit
3. Carcass Quality
    - Carcass value and overall profit (entire birth to slaughter period)

Statistical Analysis

Data from the two years of production and financial information were analyzed as a randomized complete block design with year as the block using the PROC MEANS and PROC GLM procedures of the Statistical Analysis System (SAS). The ten individual herds were the treatment structure with two years of data collection. The data was checked for normality using the PROC UNIVARIATE procedure of SAS.

Relationships between production and financial information were initially determined using correlation analysis. Following this, stepwise regression analysis was used to determine the factors predicting end measures of production at each stage throughout the chain and the end value of the animal.

Results and Discussion

Mean Comparison

Birth to Wean Period

Measures of production during the birth to wean period for the ten cow/calf enterprises throughout the 1998 and 1999 production years are presented in Table 1.1. There were significant differences ($P<0.05$) detected in mean birth weight and mean weaning weight between the ten enterprises. However, it was noted that herds that averaged high birth weights were not necessarily those that achieved high weaning weights. Even when weaning weight was adjusted to a constant age of 205 days there were differences noted between the herds in average weaning weight. This suggests that management decisions play an important role in altering overall level of production and since the majority of calves produced are sold at weaning and on a price per kilogram basis, it is understood that producers would want to achieve the heaviest weaning weights possible. However, the question that needs to be asked is, is it profitable to wean the heaviest calves or is it more cost effective to achieve a lower wean weight with a lower cost of production? That is, is it cost effective to achieve the extra weight or is it more important to maintain a low cost of production? H. Hughes from North Dakota State University stated that the common belief that beef profits and weaning weight are highly correlated is generally flawed. He further states that producers usually don't consider the added cost that accompanies these increased weights. These added costs included increased feed costs for both cows and calves and increased costs associated with labour.

It should be noted that there were large increases in the standard deviation of weaning weight as compared to the standard deviation for the birth weight within all ten herds. This suggests that at birth, calves are fairly uniform however, variability increases as the calves mature. This increased variability can be attributed to factors such as variability in milk productivity of cows or variability in the growth potential of calves.

Significant differences between the ten herds also existed in financial parameters during the birth to wean period (Table 1.2). The value received at weaning varied significantly ($P<0.05$) from a high of $838.66 per animal to a low of $459.77. Such a large variation in a central economic determinant, such as value of the product, begins to clarify the inconsistencies that exist in profitability between cow/calf enterprises. Variation in market value can be attributed to many factors. Firstly, the time of year the calf is marketed plays a major role in dictating the value of the animal. Within a production year, cattle prices vary significantly. If a producer is not monitoring the markets closely, the maximum value for the calves may not be attained. For example, if one looks at the 1999 calf market for 230 kilogram calves, the price ranged from a low of $258 to a high of $330 per hundred kilograms of live weight (Saskatchewan Agriculture and Food 1999).

The time of year the calf is marketed also plays a part in the age and weight of the calf. Since weight is such an important determinant in price received for the animal, it

must be given considerable attention and planning in order to maximize the animal value and to minimize cost of production. Finding the correct balance between time of marketing and calf weight is essential in maximizing profitability. How and where calves are marketed is also an important consideration in realizing maximum animal value, however because animals in this study were valued by the same pricing method, this was not a source of variation in comparing mean value across herds.

Cost of production per animal was determined from the cost per kilogram of gain that was derived from each enterprise and multiplying that value by the weaning weight of each individual animal. Cost of production also varied ($P<0.05$) between the ten herds with the highest mean cost of production being $845.90 per animal and the lowest averaging $525.73 per animal. Feed costs are a critical factor in determining cost of production and therefore influencing profits (Miller et al. 2001). Other factors that influence the cost of production in a cow/calf enterprise include pasture expenses, unpaid labour along with machinery and building repairs. Unpaid labour is strongly influenced by the size of the cow herd and is therefore often substantially lower for larger herds. All of these factors contribute to the wide range in cost of production that was detected among the ten enterprises.

There was a wide range in cost per animal within each herd; however because a constant cost of production was used, this is merely the result of the variation in weaning weight that exists within herds. The variation in cost of production between herds largely explains the variation in profit that was detected between the cow/calf enterprises. Producers must closely manage their costs if maximum profits are to be attained. Producers who closely monitor their costs of production can implement management strategies that reduce costs and therefore have an economic advantage over those who do not monitor their costs. Records become beneficial when this information can be used to enhance the decision making process.

From the value and cost of production measures, a profit at weaning was calculated for each individual animal and a herd average derived. As a result of the variation in value and cost of production, a large degree of variability was noted between the ten enterprises in profit at weaning across the two production years. Profits ranged from -$177.76 per animal to $274.72 per animal ($P<0.05$).

In an attempt to account for some of the variation in weaning weight due to age, a 205-day constant profit at weaning was calculated. This was estimated by valuing and costing the individual animals according to their 205-day adjusted weaning weight and thereby calculating a profit at weaning that eliminated the variation due to age at weaning. This resulted in a larger ($P<0.05$) range in profits from -$179.34 per animal to $312.33 per animal with little change in the rank of the ten enterprises in overall profitability. This increase implies that the differences that exist between cow/calf enterprises in profitability at weaning are likely not a result of the dissimilarity in average age at weaning between the herds, but reiterates the fact that costs must be measured and managed accordingly.

Wean to Finish Period

Table 1.3 summarizes the mean production data for the ten enterprises throughout the wean to finish period of the beef production chain. Again, some degree of variation was noted between the ten cow/calf herds; however, the variation in the wean to finish

period both within and between herds was not as sizeable as that recognized throughout the birth to wean period. This was expected, as the feeding period is a much more closely monitored period where cattle are fed to reach a specific end target.

Days on feed ranged between herds from the shortest of 171 to the longest of 339 days ($P<0.05$), while average daily gain varied ($P<0.05$) from 1.16 to 1.68 kilograms per day. This wide range in days on feed and average daily gain indicates that there is substantial room for improvement in these production traits and that management strategies can be implemented to improve these factors. As well, finish weight varied across herds ($P<0.05$) from 546.0 to 627.5 kilograms. This variation is similar to that found by Block et al. (2001) who in a comparison of three main beef breeds determined finish weight to range from 545.9 to 610.8 kg. When finish weight was adjusted to a 400-day constant age, as with the 205-day adjusted wean weight, the range widened slightly to 465.0 to 578.2 kilograms ($P<0.05$). It would be beneficial for producers to better understand what type of animal is desired by the feedlot sector and what they need to do to produce a calf that performs well in the feedlot. For this reason, improving information flow between the different sectors of the beef production chain is essential.

Financial parameters during the weaning to finish period are given in Table 1.4. As with the value at wean, value at finish was calculated using the Alberta Cattle Commission's daily market price for the specific day that the animals were sent to slaughter. Value at slaughter ranged from a low value of $1046.42 to a high of $1302.28 per animal ($P<0.05$). Again, there was a considerable level of within herd variation that existed in the value of the animal when finished. This variation was influenced strictly by the weight of the animal and the price received for the animal. These results further support the need for improved information flow throughout the beef production chain to assist producers in making effective management decisions.

As with value at slaughter, cost of gain during finishing differed ($P<0.05$) between the ten herds from $295.57 to $516.48 per animal. This difference in cost can be attributed to factors such as feed costs, genetics and feeding strategies. It is important that cost of production be minimized during all sectors of the production chain. Most commercial feedlots closely monitor and keep their costs to a minimum whereas cattle finished on-farm may not be so closely monitored and do not have all the advantages of the large commercial feedlots in terms of minimizing costs. Profit at finish was determined from the value at weaning and at finish and the cost of gain during feeding. As with the birth to weaning period, there was a significant ($P<0.05$) degree of variation in profitability between the ten enterprises; however the variation between the high and low profit herds was substantially smaller for the weaning to finish period with the range being from -$14.97 to $170.04 per animal. This smaller difference in profitability can most likely be attributed to the close monitoring of cattle during the feeding period. Any differences in profit are likely the result of differences in the cost of gain at the feedlot and a difference in mean value of the animals coming into the feedlot.

Carcass Information

Mean carcass production data is presented for the ten cow/calf enterprises in Table 1.5. As expected, age at slaughter did vary significantly ($P<0.05$) across the ten herds with a range of 382 to 504 days. Hot carcass weight, as with the other parameters varied significantly between the ten herds from a high of 367.3 to 330.0 kilograms

($P<0.05$). There was also a large degree of variability within herds for carcass hot weight with a range as great as 227 to 457 kilograms for Herd D.

Yield and quality grade were also documented for individual animals that were followed through to slaughter and again differences ($P<0.05$) were noted between the ten herds. The scale used to determine yield grades was as follows: yield grade 1 = 59% or more lean meat yield, yield grade 2 = 54 to 58% lean meat yield and yield grade 3 = 53% or less lean meat yield. Six of the ten herds averaged a lean meat yield of less than 1.3 and were statistically not different ($P>0.05$). Three herds averaged lower ($P<0.05$) yield grades (>1.5 and <2.0). One enterprise averaged a lean meat yield of 2.4, which indicated that this herd produced significantly fatter carcasses ($P<0.05$) than the other nine herds.

These results suggest that most enterprises are achieving lean carcasses from the calves they produce, however, some enterprises may want to consider improving their herd's average yield grade in order to increase profitability of the individual animals. This is important under a value-based system, where those animals with a higher percentage of lean meat are valued higher. Economically speaking, it would be beneficial for herds with a low lean percentage to attempt to improve this through either genetics or feeding strategies or both.

Quality grade was measured using the following scale: quality grade 1 = A, quality grade 2 = AA and quality grade 3 = AAA. All ten enterprises achieved an average quality grade of 2.0 or higher and one herd achieved an average of 2.9, which was significantly higher ($P<0.05$) than the other nine enterprises. Again, because value-based marketing is becoming more prevalent, this may be an area that cow/calf enterprises can improve upon in order to achieve higher profitability. However, if they do not measure this production parameter and receive this information they do not have a full understanding of the success or failure of the product they are producing. Carcass characteristics such as quality and yield grade have medium to high heritability with average values between .2 and .4. Therefore producers can successfully improve carcass characteristics through genetic selection if desired (Marshall 1994).

It is important to also consider the relationship carcass characteristics have with other production parameters before producers start focusing on selecting animals for these traits. Selecting for this trait may have negative effects on other important production parameters, so much consideration is required before a producer begins selecting for a specific production trait.

Carcass financial data and overall profitability for the ten cow/calf enterprises is outlined in Table 1.6. Again, a wide degree of within and between herd variability existed in both carcass value and overall profit. Carcass value was calculated based on a typical western Canadian grid pricing system and using the Alberta Cattle Commission's daily market report as the base price for the day that the individual animals were slaughtered. Value-based marketing values carcasses according to quality (marbling score) and yield grades and therefore rewards lean, highly marbled carcasses and discounts poorly marbled, low yielding carcasses. Carcass values are derived from the base price plus or minus the appropriate premium or discount multiplied by the hot carcass weight. Mean carcass value differed ($P<0.05$) between enterprises and as well, a large degree of within herd variation was observed. Carcass value ranged from $1103.91 to $1303.97 between the ten enterprises. This wide range in carcass value has a great influence on the overall profitability for each enterprise because carcass value is the end value of the product that

was initially produced by the cow/calf enterprise. There was also a sizeable degree of variation in carcass value within the ten herds with the largest range being from $835 to $1726 per animal for Herd D. This large degree of variation in carcass value suggests that many enterprises have room to improve their end product value through either selecting for yield and/or quality traits or manipulating live weight via management strategies and therefore improve overall profitability. Again, it is important to be aware of any detrimental effect that may arise from selecting for improved carcass characteristics.

Overall profitability was also ascertained for each cow/calf enterprise and is presented in Table 1.6. Each cow/calf enterprise's overall profitability was calculated based on the assumption that ownership was retained from birth through to slaughter, therefore overall profitability was calculated by subtracting cost of production at weaning and feedlot cost of gain from the individual carcass value. There were significant differences ($P<0.05$) in overall profit between the ten enterprises with the highest average profit being $341.46 per animal and the lowest –$172.38 per animal. Overall profit also varied substantially between individual animals within the ten enterprises. The largest variation in profit within a herd ranged from -$321 to $553 per animal within Herd I.

This wide range of within herd variability indicates that improvements in overall profit can be made if individual animal records are kept and given the correct amount of consideration. For example, as previously stated, feed costs are the largest single cost factor associated with beef production and that reducing the amount of harvested forages needed by either less wastage or extending the grazing season would be profitable management strategies. As well, H. Ritchie from Michigan State University concluded that the crossbred cow is a necessary ingredient for maximizing profits due to the extent of maternal heterosis. The challenge is for producers to utilize the appropriate breeds for their enterprise. These along with numerous other management strategies can be utilized by beef producers to improve enterprise profitability.

Pearson Correlation Analysis

Birth to Wean Period

Table 1.7 gives details of the Pearson correlation analysis carried out to determine the tendency of two variables to be related in a definite manner. Correlations between numerous key production and financial parameters were measured during the birth to wean period. Correlation coefficients (r) are reported for only those correlations that have a significance level of at least $P<0.05$.

As expected weaning weight and age at weaning were highly correlated with an r value of 0.81 as well as wean weight and value at wean with an r of 0.93. This positive correlation concurs with Hughes (1992) who noted that heavier calves gross more dollars per head. This is due to the fact that the majority of calves are sold in an auction setting and buyers value the calf based on weight.

Profit at wean was correlated ($P<0.0001$) with weaning weight ($r = 0.40$) and value at weaning ($r = 0.53$). These relatively high correlations were expected because currently beef cattle are sold at weaning and priced according to weight. It can also be assumed that the higher the value received for each animal, the more likely higher profits are to be achieved.

High correlations were detected between value at weaning and age at weaning and weaning weight (Table 3.8). However, the correlations were not as strong with the more important variable profit at wean. This again indicates that while the value of the animal is strongly influenced by age and weight, high weaning weights will not always result in high profits for the enterprise.

Wean to Slaughter Period

Pearson correlation analysis for the weaning to slaughter period are shown in Table 1.8. Only those correlations with r values that were significant at a minimum level of $P<0.05$ were reported. As expected, wean weight and final weight were positively correlated with an r value of 0.41 ($P<0.0001$) while wean weight and days on feed were negatively correlated with an r value of –0.78 ($P<0.0001$). Wean weight was positively correlated with average daily gain, hot carcass weight and quality grade with r values of 0.47, 0.38 and 0.20 respectively ($P<0.0001$). Wean weight was negatively correlated with yield grade with a small correlation coefficient of –0.05 ($P<0.05$) and also was negatively correlated with profit at finish with a r value of –0.36 ($P<0.0001$). Since the correlation between weaning weight and yield grade was minor, it likely does not refer to a cause and effect relationship and is more probable that there is a lack of relationship between these two variables.

It is more difficult to identify the reasons for the negative relationship between weaning weight and profit at finish (r = -0.36); however the high correlation (r = 0.93) between weaning weight and weaning value would suggest that the value of a heavier animal is much higher at the beginning of the feeding period. This would make it more difficult to achieve a profit during the feeding period from these heavy animals. That is, finish profit is calculated as live slaughter value minus weaning value and feedlot cost of gain. Therefore, the higher the weaning value, the lower the finish profit. This may not be the case at all times due to the fact that the higher the weight at weaning the less weight that has to be put on during the feeding period. However, it may explain the negative correlation that was noted in this data set.

Both live slaughter value and carcass value were positively correlated with weaning weight with r values of 0.47 and 0.43 respectively ($P<0.0001$). This correlation was expected because value of the carcass is based on hot carcass weight. Wean weight and hot carcass weight were also positively correlated.

Profit at finish is the key financial parameter to consider during the wean to slaughter period. As expected, there was a significant ($P<0.0001$) positive correlation with final weight (r = 0.25). A significant positive correlation ($P<0.0001$) was also established between profit at finish and days on feed (r = 0.46). This is likely the result of the increase in weight that is achieved with increased time on feed. The heavier the animals the higher profits as long as the cost of gain remains lower than the value of the weight gain.

Profit at finish was slightly correlated with average daily gain, carcass hot weight and to a greater degree live slaughter value with r values equal to 0.05, 0.19 and 0.37 respectively. Profit at finish was also positively correlated ($P<0.0001$) with carcass value (r = 0.31). As mentioned earlier, carcass value was derived using a grid pricing system with premiums paid for high marbling and yield grades.

Carcass value was positively correlated ($P<0.0001$) with wean weight, profit at wean, final weight, average daily gain, carcass hot weight and live slaughter value with r values equal to 0.43, 0.26, 0.68, 0.53, 0.76 and 0.89 respectively. All of these positive correlations indicate that a productive animal is associated with a highly valued carcass. Little association was detected between carcass value and quality grade ($P>0.05$) or yield grade ($r = 0.06$).

Overall profit is the key financial measure throughout the entire production chain of the beef animal. In this data set overall profit was positively correlated ($P<0.0001$) with wean weight, final weight, average daily gain, carcass hot weight and carcass value with r values equivalent to 0.22, 0.13, 0.18, 0.17 and 0.42 respectively.

In this data set where information on production and financial parameters were collected from birth to slaughter it would be of value to predict key production endpoints such as weaning weight and final weight as both are associated with value of the animal at these points. Pearson correlation analysis shows the most likely predictor variables for weaning weight to be age at weaning ($r = 0.81$) and birth weight ($r = 0.34$). For final weight these are likely to be weaning weight ($r= 0.41$) and average daily gain in the feedlot ($r = 0.55$).

Stepwise Regression Analysis

Birth to Wean Period

Stepwise regression analysis was utilized in an attempt to determine factors that might predict the end measure of production for the birth to weaning period with weaning weight being the dependent variable. Table 1.9 shows the factors that affect weaning weight when animals from all ten herds for both years are used to derive the model. Birth weight, age at wean and sex were all included as predictor variables in the model. The predictor variables that were used to derive the weaning weight regression equations were birth weight, age at wean and sex of the calf with no financial variables included because financial measures during this period are highly influenced by the weight of the animal at weaning.

The coefficient of determination (R^2) value provides an indication of the amount of variation in the independent variable accounted for by the dependent variables. The R^2 value for this prediction equation was 0.31. This R^2 value indicates that the equation developed was moderately successful in predicting weaning weight. This implies however that there are numerous other factors that account for a significant amount of the variation in this variable and are not accounted for by the model. This is further shown when one looks at the prediction of weaning weight within each of the ten herds (Data not shown). The dependent variables used to predict weaning weight varied from one herd to the next and the variation accounted for by the model ranged from $R^2 = 0.12$ to 0.57.

The important predictor variables of weaning weight determined from this data set are birth weight, age at weaning and sex of the calf. Age at wean had the largest effect on weaning weight. Both sex of the calf and birth weight had a considerably smaller influence on weaning weight.

Wean to Finish Period

The dependent variable used for the end measure of production for the wean to finish period was final weight with average daily gain, days on feed, weaning weight, age at wean and sex being the independent variables.

Table 1.10 presents the regression equation derived for final weight for all observations in the ten herds. Weaning weight, age at wean, sex, average daily gain and days on feed were all included as significant predictors of the model. When included in the prediction equation both days on feed and weaning weight had only a small positive effect on final weight. Average daily gain seemed to be the variable that had the largest influence on final weight with a large positive coefficient in the final regression model. The R^2 value calculated for this regression equation was 0.33. This again suggests that these predictor variables are only moderately successful at fitting the predicted to the actual data for final weight. Again, there is a large amount of variation that is not accounted for by the model and therefore numerous factors could account for this variation. As with the birth to wean period, when each herd was looked at individually (data not shown), the variables used to predict final weight varied from one herd to the next along with the variation accounted for by each model (R^2 = 0.58 to 0.91). This again indicates that there are many variables influencing final weight and that the nature and importance of these variables will vary from one herd to the next.

Carcass Information

Regression equations were also derived for each cow/calf enterprise with carcass value being used as the end financial measure for the entire production chain. A model was also developed which included all animals from all herds and accounted for the potential clustering within herds. Variables that were incorporated in an attempt to derive prediction equations for carcass values were final weight, average daily gain, days on feed, weaning weight, age at wean and sex. Table 3.11 outlines the model that was derived from all observations across the ten herds. Weaning weight, age at wean, days on feed and average daily gain were included as predictor variables of the final model. The coefficient of determination (R^2) was calculated to be 0.25 for this model. As with the other models, a significant amount of the variation in carcass value is not accounted for by this model.

Conclusions and Implications

The results from this study indicate that a large degree of variation exists both within and between cow/calf enterprises in western Canada in terms of production and economic parameters throughout the beef production chain. Production measures such as weaning weight, age at wean, days on feed, final weight and hot carcass weight varied greatly within and between herds. This variability illustrates that there is tremendous opportunity for improvement in these significant end measures of production in western Canadian cow/calf enterprises.

As the beef industry moves closer to value-based marketing systems, knowledge of this within and between herd variability will help producers target specific markets through informed breeding and management programs. Understanding the financial implications of the improvement of these production parameters should also be a strong focus for producers. Financial considerations need to be carefully considered before production decisions are finalized. Further research is needed if producers are able to utilize this type of information to its full advantage. A better understanding of what production factors influence profitability and what needs to be done in order to maximize profits is needed and will help producers utilize this information to their benefit.

This research indicates the relationship between key endpoints such as weaning weight, final weight and carcass value and those production traits that influence their final value. For example, averaged across the ten herds weaning weight, age at wean, days on feed and average daily gain were all important factors in predicting carcass value.

Many new marketing opportunities are available to producers such as retained ownership, branded beef programs and industry alliances. Through these programs producers can receive production information on their animals and are paid according to the quality of animal produced. Programs that allow producers to receive information on the financial and production success of their animals from birth through to slaughter can assist producers with management decisions that are profitable both to them and to the beef industry as a whole. However, without proper knowledge of their current production and financial standing these programs can lead to substantial losses. The majority of these programs pay ranchers for producing a quality, consistent product and if they do not have a complete understanding of how their animals perform throughout the entire production chain these marketing alternatives can be very costly.

Table 1. Birth to wean production data from ten cooperating cow/calf herds across Saskatchewan and Alberta during 1998 and 1999

	Herds										
	A	B	C	D	F	G	H	I	J	K	Pooled SEM
Birth weight (kgs)	39.0cd	-	42.5a	38.2d	-	36.5e	43.2a	40.7b	39.6c	40.9b	0.30
SD	6.6		6.6	3.2		4.8	6.5	5.5	4.9	6.5	
Range	16-57		23-59	25-48		20-57	22-65	22-65	25-61	23-59	
N	251		161	825		438	458	215	336	629	
Wean weight (kgs)	341.7a	290.1e	286.5e	177.0h	319.9b	230.5g	258.3f	235.3g	298.5d	308.3c	2.25
SD	32.1	30.0	34.7	28.6	38.5	33.0	42.0	38.9	31.8	44.3	
Range	250-411	193-368	182-368	66-250	204-418	132-368	141-381	136-364	127-368	143-423	
N	160	298	126	441	251	419	457	295	204	595	
205-d Adjusted weight (kgs)	274.8b	-	270.5b	239.0d	-	242.3d	264.0c	264.0c	272.0b	284.5a	2.33
SD	26.0		26.6	35.4		32.7	35.0	36.8	28.4	34.8	
Range	183-341		197-329	75-322		141-341	148-369	163-385	115-350	133-376	
n	84		126	441		419	429	208	204	582	
Age at wean (days)	264a	209e	220d	141i	250b	194g	200f	183h	229c	226c	1.21
SD	18	12	23	12	21	20	24	24	16	22	
Range	208-311	171-244	168-260	107-189	190-296	110-245	131-249	87-252	184-258	150-273	
n	162	315	126	443	261	420	462	295	208	618	

a-i Means in the same row followed by different letters are significantly different (P<0.05)
SEM = Standard error of the mean
SD = Standard deviation

Table 2. Birth to wean financial data from ten cooperating cow/calf herds across Saskatchewan and Alberta during 1998 and 1999

	Herds										
	A	B	C	D	F	G	H	I	J	K	Pooled SEM
Value at wean ($/animal)	838.66a	730.23d	741.08d	459.77g	810.05b	644.78f	683.28e	632.13f	745.64d	762.74c	4.97
SD	86.90	84.11	103.12	64.99	92.91	104.54	97.37	120.10	70.35	105.61	
Range	382-984	519-932	442-931	189-618	524-1012	332-903	389-932	338-912	456-892	359-989	
n	162	298	126	441	251	419	457	295	204	595	
Cost of production ($/animal)	569.57e	525.73f	845.90a	557.74f	688.81c	758.51b	752.22b	553.62ef	624.23d	609.22d	8.73
SD	231.01	62.04	100.67	86.22	206.96	125.60	136.56	118.21	68.29	94.88	
Range	301-1032	382-716	643-1072	199-754	353-1108	432-1207	384-1182	252-896	272-761	318-853	
n	160	298	63	441	251	213	455	295	204	595	
Profit at wean ($/animal)	274.72a	204.50b	-36.94f	-73.73g	120.67d	-177.76h	-69.07g	78.52e	121.41d	153.52c	9.25
SD	280.51	86.58	42.45	21.96	235.47	34.53	108.43	190.25	22.85	108.11	
Range	-158-536	54-329	-160-67	-135--10	-180-442	-304--100	-276-133	-175-318	68-199	-5-342	
n	160	298	63	441	251	213	455	295	204	595	
205-d Profit at Wean ($/animal)[1]	312.33a	-	-30.31d	-125.39e	-	-179.34f	-95.09e	146.89b	126.69bc	110.36c	10.99
SD	235.20		1.58	24.69		30.99	119.79	175.58	22.33	64.93	
Range	-64-530		-32--28	-175--23		-282--107	-295-131	-185-324	82-211	-5-296	
n	80		14	441		209	413	207	197	580	

a-h Means in the same row followed by different letters are significantly different (P<0.05)
SEM = Standard error of the mean
SD = Standard deviation
[1] Values calculated using 205-day adjusted wean weight

Table 3. Wean to finish production data from ten cooperating cow/calf herds across Saskatchewan and Alberta during 1998 and 1999

	Herds										
	A	B	C	D	F	G	H	I	J	K	Pooled SEM
Days on feed (days)	171f	174f	202d	339a	186e	187e	292b	294b	171f	215c	2.51
SD	11.9	8.2	22.7	24.6	37.3	0	54.7	18.6	13.7	24.6	
Range	154-188	167-186	177-239	294-364	127-301	187-187	191-419	268-317	152-181	161-246	
n	155	286	89	306	68	49	196	79	129	369	
Average daily gain (kgs/day)	1.68a	1.53b	1.63a	1.16d	1.52b	1.46b	1.27c	1.24c	1.51b	1.29c	0.02
SD	0.21	0.20	0.23	0.20	0.22	0.20	0.23	0.12	0.24	0.20	
Range	1.1-2.2	0.8-2.0	1.0-2.2	0.6-1.7	1.0-2.0	1.1-2.1	0.8-2.0	0.9-1.6	1.0-2.0	0.7-1.8	
n	141	280	89	305	68	45	195	79	129	361	
Finish weight (kgs)	627.5a	554.8c	609.4a	572.0b	626.8a	547.3c	618.5a	609.5a	546.0c	584.8b	4.80
SD	47.9	49.8	47.8	58.4	29.0	42.2	51.8	39.1	51.4	55.3	
Range	499-755	429-706	477-705	389-744	565-714	478-650	487-750	518-710	405-660	412-729	
n	153	280	90	538	68	46	199	81	167	376	
400-d Adjusted finish weight (kgs)	578.2a	-	585.0a	465.0d	-	556.3b	516.6c	522.4c	549.3b	541.1b	5.70
SD	53.3		50.9	60.0		45.4	57.7	38.0	56.8	58.9	
Range	426-685		466.675	340-656		465-655	376-652	427-590	417-699	356-676	
n	81		90	535		45	185	54	165	367	

a-f Means in the same row followed by different letters are significantly different (P<0.05)
SEM = Standard error of the mean
SD = Standard deviation

Table 4. Wean to finish financial data from ten cooperating cow/calf herds across Saskatchewan and Alberta during 1998 and 1999

	Herds										
	A	B	C	D	F	G	H	I	J	K	Pooled SEM
Value at finish ($/animal)	1283.55a	1135.67d	1269.77a	1186.65c	1302.28a	1046.42f	1235.27b	1181.37c	1080.63e	1178.22c	9.87
SD	128.97	114.87	119.44	138.77	92.37	81.57	118.20	86.39	109.94	150.29	
Range	959-1610	838-1536	921-1519	742-1671	1103-1460	913-1242	927-1548	978-1365	773-1299	836-1542	
n	152	280	90	536	68	45	199	80	166	375	
Cost of production ($/animal)	303.82f	310.40f	348.87e	490.05b	295.57f	379.96d	516.84a	374.89d	401.49c	375.07d	5.25
SD	32.38	39.29	42.87	68.28	40.46	52.49	81.02	71.35	53.51	48.96	
Range	219-386	175-418	248-451	247-656	216-390	277-538	342-753	213-504	278-564	239-498	
n	140	280	89	305	68	45	101	80	129	361	
Profit at finish ($/animal)	135.65c	95.65e	153.46b	170.04a	112.49d	-14.97h	79.02f	150.93b	-64.88i	33.09g	4.37
SD	55.42	43.15	45.15	43.26	86.40	22.41	68.94	43.11	20.75	45.85	
Range	16-322	-53-229	48-271	11-315	-109-223	-56-44	-53-278	7-235	-115-60	-85-167	
n	140	280	89	305	68	45	101	80	129	361	

a-i Means in the same row followed by different letters are significantly different (P<0.05)
SEM = Standard error of the mean
SD = Standard deviation

Table 5. Carcass production data from ten cooperating cow/calf herds across Saskatchewan and Alberta during 1998 and 1999

	Herds										
	A	B	C	D	F	G	H	I	J	K	**Pooled SEM**
Age at slaughter (days)	436d	382g	419e	504a	441d	394f	488b	476c	399f	437d	7.04
SD	19	13	20	36	34	15	52	17	20	28	
Range	375-493	348-413	361-487	411-582	382-541	370-432	386-625	429-521	351-439	347-495	
n	170	286	90	538	68	49	199	81	167	378	
Hot carcass weight (kgs)	356.8ab	334.6c	358.3ab	345.8b	367.3a	330.0c	354.2ab	347.7b	326.3c	354.2ab	3.73
SD	25.2	32.5	30.6	37.9	14.4	27.1	26.6	26.0	30.2	35.8	
Range	299-414	253-433	271-427	227-457	347-397	285-396	290-420	284-419	240-391	242-447	
n	104	280	90	538	18	47	196	81	167	378	
Yield grade[1]	1.2c	1.6b	1.3c	1.5b	1.6b	2.4a	1.1c	1.1c	1.2c	1.2c	0.06
SD	0.4	0.7	0.5	0.6	0.7	0.6	0.4	0.3	0.5	0.4	
Range	1-3	1-3	1-3	1-3	1-3	1-3	1-3	1-2	1-3	1-3	
n	103	280	88	528	18	46	191	81	167	376	
Quality grade[2]	2.5b	2.3bcd	2.4bc	2.0d	2.2cd	2.9a	2.3bc	2.4b	2.0d	2.4bc	0.07
SD	0.6	0.6	0.5	0.7	0.5	0.3	0.5	0.6	0.5	0.5	
Range	1-3	1-3	1-3	1-3	1-3	2-3	1-3	1-3	1-3	1-3	
n	104	280	90	536	18	47	189	81	167	376	

a-g Means in the same row followed by different letters are significantly different (P<0.05)
SEM = Standard error of the mean
SD = Standard deviation
[1]Yield grade: Canada 1=59% or more lean, Canada 2=54 to 58% lean, Canada 3=53% or less lean
[2]Quality grade: 1=A, 2=AA, 3=AAA

Table 6. Carcass financial data from ten cooperating cow/calf herds across Saskatchewan and Alberta during 1998 and 1999

	Herds										
	A	B	C	D	F	G	H	I	J	K	**Pooled SEM**
Carcass value ($/animal)	1238.85bc	1176.42d	1303.97a	1221.57bc	1265.15b	1103.91e	1214.91c	1167.90d	1106.85e	1228.48bc	13.01
SD	116.43	125.00	140.95	154.06	99.36	87.73	118.28	105.17	110.15	160.40	
Range	977-1504	838-1562	883-1570	835-1726	1116-1457	951-1321	962-1556	964-1478	779-1351	835-1671	
n	103	280	88	527	18	46	184	81	166	372	
Overall profit ($/animal)	218.52b	341.46a	182.23b	122.15c	185.28b	-172.38d	104.42c	198.72b	72.50c	236.48b	15.99
SD	267.61	110.37	48.32	60.46	305.68	49.79	125.32	220.79	27.78	139.30	
Range	-62-690	117-560	58-292	-111-308	-194-589	-274--61	-117-434	-321-553	10-243	31-545	
n	86	280	62	294	18	43	90	80	129	355	

a-e Means in the same row followed by different letters are significantly different (P<0.05)
SEM = Standard error of the mean
SD = Standard deviation

Table 7. Pearson correlation analysis of 1998 and 1999 herd records from birth to weaning

	Birth Weight	Weaning Weight	Age at Wean	205 day Adj. Wean weight	Value at Wean	Profit at Wean
Birth Weight	-	0.34	0.09	0.47	0.34	NS
Weaning Weight		-	0.81	0.77	0.93	0.40
Age at Wean			-	0.26	0.76	0.37
205 day Adj. Wean Weight				-	0.71	0.20
Value at Wean					-	0.53
Weaning Profit						-

Correlations reported are significant at $P<0.05$
NS = Not Significant

Table 8 Pearson correlation analysis of 1998 and 1999 herd records from wean to slaughter

	Wean Weight	Profit at Wean	Final Weight	Days on Feed	Average Daily Gain	Hot Carcass Weight	Quality Grade	Yield Grade	Live Slaughter Value	Profit at Finish	Carcass Value	Overall Profit
Wean Weight	-	0.53	0.41	-0.78	0.47	0.38	0.20	-0.05	0.47	-0.36	0.43	0.22
Profit at Wean		-	0.11	-0.45	0.29	0.06	0.09	-0.11	0.33	-0.09	0.26	0.89
Final Weight			-	NS	0.55	0.94	NS	-0.07	0.87	0.25	0.68	0.13
Days on Feed				-	-0.64	NS	-0.18	NS	-0.11	0.46	-0.12	-0.20
Average Daily Gain					-	0.52	NS	0.05	0.55	0.05	0.53	0.18
Carcass Hot Weight						-	NS	NS	0.85	0.19	0.76	0.17
Quality Grade							-	0.18	NS	-0.13	NS	NS
Yield Grade								-	-0.06	NS	0.06	-0.10
Live Slaughter Value									-	0.37	0.89	0.39
Profit at Finish										-	0.31	0.24
Carcass Value											-	0.42
Overall Profit												-

Correlations reported at a minimum significance level of P<0.05
NS = Not Significant (P>0.05)

Table 9. Factors affecting mean weaning weight throughout 1998 and 1999 production years.

	β Estimate	Standard Error	Lower 95% Confidence Interval	Upper 95% Confidence Interval	*P*-Value
Intercept	-229.74	11.55	-252.39	-207.09	<0.0001
Parameter					
Birth Weight	2.78	0.04	2.71	2.86	<0.0001
Age at Wean	20.06	2.75	14.67	25.46	<0.0001
Sex (1)[1]	2.60	0.11	2.39	2.82	<0.0001
$R^2 = 0.31$					

[1]Sex(1) = male animals

Table 10. Factors affecting mean final weight throughout 1998 and 1999 production years.

	β Estimate	Standard Error	Lower 95% Confidence Interval	Upper 95% Confidence Interval	*P*-Value
Intercept	-504.32	15.02	-533.79	-474.85	<0.0001
Parameter					
Weaning Weight	0.97	0.01	0.94	0.99	<0.0001
Age at Wean	-0.14	0.04	-0.22	-0.06	0.0012
Sex (1)[1]	20.95	2.14	16.74	25.16	<0.0001
Days on Feed	2.57	0.02	2.52	2.62	<0.0001
Average Daily Gain	203.85	2.03	199.86	207.84	<0.0001
$R^2 = 0.33$					

[1]Sex(1) = male animals

Table 11. Factors affecting mean carcass value throughout 1998 and 1999 production years.

	β Estimate	Standard Error	Lower 95% Confidence Interval	Upper 95% Confidence Interval	*P*-Value
Intercept	-411.33	34.30	-478.63	-344.03	<0.0001
Parameter					
Weaning Weight	1.05	0.03	1.00	1.11	<0.0001
Age at Wean	-0.46	0.10	-0.65	-0.27	<0.0001
Days on Feed	2.13	0.06	2.02	2.24	<0.0001
Average Daily Gain	187.65	4.41	178.97	196.32	<0.0001
$R^2 = 0.25$					

Study Area 2
Analysis of Financial and Production Factors Influencing Profitability of the Cow/calf Enterprise

Introduction

Increasingly, beef production is becoming a competitive industry where in order to achieve success, the producer must fully evaluate and assess all aspects of the enterprise. This involves a complete understanding of both the production and financial facets of the enterprise. It is essential that producers appreciate the importance of having a full awareness of both financial and production parameters within the herd and the role these measurements play with respect to the enterprise's overall success.

Once a producer recognizes the importance of keeping both production and financial records, the information can then be utilized to improve the profitability of the enterprise. Production parameters including calving percentage, calf losses, weaning rates and weaning weights have long been thought to be critical indicators of a herd's productivity. Emphasis has been placed on selection for growth traits. This seemed to be a logical step as most cow/calf operators sell their calves at weaning and weight is an important parameter determining gross income. However, without considering the cost related to this increased production, producers are not necessarily making a profitable decision.

Increasing emphasis is now being placed on the economic aspects of the cow-calf enterprise, with producers focusing on low cost production practices. Understanding what factors contribute to the profitability of the cow/calf enterprise is the first step in fully recognizing the potential financial success of the herd. At North Dakota State University, researchers have worked with a group of cow/calf operators throughout the state that are involved in an integrated resource management program. These producers are grouped annually into low and high cost producers and economic traits between groups are compared in an attempt to more fully categorize these producers. Knowledge of production factors that are associated with high and low profit herds would also be a valuable extension tool that producers could use to change management practices. Currently, no information exists in western Canada that allows statistical comparison of production parameters between high and low profit producers.

The Whole Farm Cost of Production program at the Western Beef Development Centre involves participating producers supplying information on various production and financial measures for each farm enterprise and from this information, cost of production for each herd is calculated. This program has provided the opportunity for a comparison of production and financial parameters between cow/calf enterprises in Saskatchewan with varying levels of profitability. The objective of this project was to rank cooperating cow/calf enterprises over a two year period according to the profitability of the operation and to examine differences between high and low profit operations in terms of key production and financial parameters. Knowledge of the production and financial indices associated with high profit herds can then be used as a valuable extension tool to assist low profit producers to make improvements.

Materials and Methods

Data Analysis

The data set is based on data collected across two years (1998 and 1999 calf crops) from participating cow/calf producers throughout Saskatchewan. This data is part of a larger whole farm cost of production study carried out by the Western Beef Development Centre and Saskatchewan Agriculture and Food. The objective of the Whole Farm Cost of Production program is to provide producers with detailed financial information on their farming and livestock operations.

In order to compare production and financial parameters between high and low profit operations, these herds were divided into four groups based on overall profitability of their cow/calf enterprise. The low profit group consisted of cow/calf enterprises with a profit of less than -$200 per cow wintered in 1998 and less than -$40 in 1999. The medium-low group had profits that were greater than -$200 and less than -$20 in 1998 and greater than -$40 and less than $170 in 1999. The medium-high category had profits between $0 and $205 in 1998 and $170 and $350 in 1999. Those enterprises with profits greater than $205 per cow wintered in 1998 and greater than $350 in 1999 were grouped into the high profit category. These divisions were made in order to obtain relatively equal distribution of herds within each profit group.

In 1998, data was collected on a total of 35 cow/calf herds. In 1999, 52 herds participated in the Whole Farm Cost of Production program. Data was collected for each producer using a standard form for each enterprise that was completed on-farm by producers with the assistance of staff from either the Western Beef Development Centre or Saskatchewan Agriculture and Food. The cow/calf enterprise form requires a breeding herd profile, breeding season information, calving information, weaning information, livestock purchases and revenue generated from weaned calf sales, feeder sales, culled cows and bulls. A whole farm enterprise analysis is also done which combines the cow/calf enterprise with other farm enterprises that the producer has. This requires an inventory of machinery and equipment, buildings and improvements, along with the percent that each is used for the different enterprises. Revenue and expenses for each enterprise are also outlined along with labour, whether hired or family. The amount of labour is allocated between the different farm enterprises. From the data collected, a total of 19 cow/calf enterprises participated in both 1998 and 1999 and were therefore used in the complete analysis conducted across the two production years.

Specific production parameters for the cow/calf enterprise that were collected included: number of females exposed, number of bred females purchased and sold, number of open cows culled and kept, length of breeding period and conception rate. Number of females exposed is a measure of the number of females exposed to the bull and therefore should be bred. To this value, the number of bred females purchased are added and the number of bred females sold, open cows culled, open females kept back and the cow deaths prior to calving are subtracted. The length of the breeding season is measured from the start of the breeding period or bull turnout, until the bulls are removed from the cow herd. Conception rate is a key measure of breeding performance and is the number of bred females per female exposed expressed as a percentage.

Parameters collected measuring calving success were: number of sets of twins, number of calves born dead or aborted, length of calving period, percentage of calves

born in the first two cycles, and calving rate. The length of the calving period is a measure of the number of days from the date of the first calf born until the date of the last calf born. The percentage of calves born in the first two cycles is a measure of the number of calves born in the first 42 days of calving as compared to the total number of bred females or expected calves. Calving rate is a key measure of calving success in the cow/calf enterprise and is a measure of the number of livebirths expressed as a percentage of the total number of bred females.

Calving difficulties were also analyzed based on percentage of caesarean sections, percentage of hard pulls, percent moderately assisted and percentage of unassisted births. The parameters that were collected for the birth to weaning period were: number of calves lost at pasture, number of baby calves purchased and sold, total number of calves weaned, average wean weight of both steers and heifers, kilograms weaned per cow exposed and weaning rate (number weaned per livebirths).

Financial variables were also collected for each herd. The variable costs collected were costs associated with: winter feed, bedding, pasture, vet and medicine, breeding fees, trucking and marketing, fuel, machine and building repairs, utilities, custom work, operating interest, paid (hired labour) and unpaid labour (owner or family labour). All costs were based on commercial costs. This was done even if the producer provided their own winter feed and bedding and owned the pasture, as these inputs that were used for the cow/calf enterprise needed to be purchased from other farm enterprises. For example, the winter feed and bedding is purchased from either the forage or crop enterprise and the usage of summer pasture must be purchased from the pasture enterprise. As mentioned earlier, costs associated with machinery or buildings are determined from the percent that each is used for the cow/calf enterprise. Paid labour is the cost associated with hired help to the enterprise while unpaid labour the amount of labour that should be paid to family or the operator for labour put into the cow/calf enterprise.

Capital costs included: share/lease payments, taxes/insurance/license costs, equipment and building depreciation and paid capital interest. As with some variable costs, capital costs are allocated between the different enterprises as a percent of the amount the operator deems appropriate.

Value of production variables collected included value received from: weaned calves, feeder cattle, purebred animals, cull cows/open heifers, bulls, miscellaneous, government programs and inventory adjustment. Cattle purchases are included in the value of production variables as a negative value that is subtracted from the total value of production. An inventory adjustment is included in order to account for changes in inventory due to cattle purchases or increasing animal value.

All variables were collected for each herd in each of the two years and then average values calculated within each profit group to determine if differences in mean production or financial variables could be noted. Differences in production or financial parameters could add insight into the large degree of variability that exists across cow/calf enterprises in western Canada and what specific parameters are responsible for this variation.

Statistical Analysis

The data was analyzed as a randomized complete block design with year as the block and the four profitability groups as the treatment structure. Means for each profitability group were calculated using the General Linear Model of SAS Institute Inc. (1989). The means of the various production and financial measures were calculated and compared across the four profitability groups using the Student-Newman-Keuls test of the Statistical Analysis System (SAS) in an attempt to determine what production and financial variables are associated with profitable herds and thus provide a yardstick which can be used as an extension tool to improve profitability of low profit enterprises.

Results and Discussion

Production Parameters

Number of cows wintered and breeding performance variables were collected and results presented in Table 2.1. There were significant differences in both the number of cows wintered and the number of females exposed between the low and high profit groups. The low profit group had on average 65.4 cows wintered and 66.3 females exposed, whereas the high profit group had an average of 164.4 cows wintered and 188.1 females exposed. As a result of this difference, there was also a significant difference detected in the number of bred females with the low profit group averaging 60.2 and the high profit group averaging 167.3 bred females. Economies of scale measure the relationship between the size of the operation (number of cows) and the profitability or the cost of production associated with the enterprise. Langemeier and associates (1995) found that larger herds had lower costs of production up to a herd size of 1000 head. They concluded that economies of scale do exist for cow/calf production. The difference detected in this data set can therefore most likely be explained by economies of scale theory.

There were no other significant differences detected between length of breeding period between the four profit groups, however the low and medium-low profit groups had the longest breeding periods with 157.3 and 203.8 days respectively. All four profit groups did average surprisingly long breeding periods with the medium-high profit group having the shortest breeding period of 129.6 days. The length of the breeding season determines the length of the calving season and it is a recommended management practice to try and achieve a calving season of 65 days or less. Bellows and Short (1994) stated that a cow must conceive by 80 days postpartum if she is to attain a 365-day calving interval. Wiltbank (1970) stated that long breeding seasons perpetuate poor reproductive performance. This data set shows that all producers involved are not achieving a short breeding season and therefore may want to investigate the benefits of shortening the breeding season.

Conception rate also did not differ significantly between the four profit groups. Table 2.1 shows that conception rate differed only slightly between the groups, ranging from 89.4% to 95.4%. The data presented here shows that on average producers are achieving relatively good conception rates and that conception rates are not a cause of the reduced profitability of some herds.

Calving production variables (Table 2.2) were also analyzed and as dictated from the differences in herd size there was a significant difference ($P<0.05$) in the total number of cows and heifers calving. However, there was no significant difference ($P>0.05$) in the calving rate (number of livebirths per bred female) between the low (96.9%) and the high (97.4%) profit groups. This did not concur with Sprott et al. (1998) who in an analysis of 32 East Texas ranches determined that calving rate and percent calf crop did differ significantly between profitable and unprofitable ranches. There was also no difference ($P>0.05$) detected in the percentage of calves born in the first two cycles or first 42 days of calving between the four groups. However, percentages ranged from 46.2% for the low profit group up to 70.8% for the medium-high profit group. The medium-low and high profit groups averaged 69.9% and 58.3% respectively. Lasley (1987) concluded that producers should aim for 70 to 80% of the cow herd to conceive on the first service. This suggests that all of the herds within the study have the opportunity to improve upon their herd productivity by more closely monitoring the breeding season and focusing management strategies on improving the number of cows that conceive early in the breeding season.

Calving success was also evaluated across the four profitability groups by measuring the percentage of caesarean sections, hard pulls, moderate assists and unassisted births with results of these parameters presented in Table 2.3. No significant differences ($P>0.05$) were detected for any of these variables between the four profitability groups. These variables, measured to determine calving production, indicate that when herds are divided into profitability groups no differences can be determined in initial production parameters based on profitable enterprises.

Production at time of weaning was also evaluated using numerous variables common for measuring production levels and are reported in Table 2.4. No significant difference ($P>0.05$) was detected between the four profitability groups for weaning rate (calves weaned per live births). There was also no difference ($P>0.05$) detected in the average weaning weight for either steers or heifers, weight per day of age or kilograms weaned per female exposed between the four profitability groups. Sprott et al. (1998) also found no difference in weaning weight or kilograms weaned per female exposed between profitable and unprofitable herds. The lack of differences in these important parameters suggests that all herds within this data set are achieving a good level of production management and that differences in profitability are likely a result of insufficient management of the financial aspects of the enterprise.

Financial Parameters

Average variable costs for the four profitability groups are presented in Table 2.5. Variable costs are defined as the costs directly associated to production and these costs would not exist if production ceased. Differences in variable costs were seen when profitability groups were compared. Significant differences ($P<0.05$) in winter feed costs were detected between the top three groups and the low profit group. No differences ($P>0.05$) were seen between the high, medium-high and medium-low groups who had average winter feed costs of $117.89, $148.02 and $182.45 per cow, respectively. The low profitability ranking had a significantly higher average winter feed cost of $240.89 per cow. This increased winter feed cost leads to a higher cost of production and therefore reduces the profitability of the enterprise. Miller et al. (2001)

concluded that feed costs account for 50% of the variation in profit between cow/calf herds and that this factor is the most critical in determining profit.

No significant differences ($P>0.05$) were seen between groups in bedding, pasture, vet and medicine, breeding fees, trucking and marketing and fuel costs. However, there was a significant difference in expenses associated with machine repairs identified between the groups. Again, the high, medium-high and medium-low profit groups did not significantly differ ($P>0.05$) and averaged $10.41, $14.50 and $10.28 per cow, respectively. The low profit group averaged $35.64 per cow in machine repair expenses, over three times as much as the high profit group. This likely is a result of low profit groups averaging smaller herds and therefore using older equipment that needs more repair and not being able to carry the expense of having newer equipment because there are fewer animals to spread the cost over.

There was also a significant difference ($P<0.05$) between the low and high profit groups in the amount of unpaid labour. Unpaid labour can be defined as the cost associated with labour that is provided to the business by the owner, family members or other people that is not paid out by the enterprise. The high profit group average $54.65 per cow in unpaid labour expense while the low profit group averaged a significantly higher ($P<0.05$) unpaid labour expense of $131.02 per cow. This difference is likely due to the higher number of cows wintered in the high profit group as compare to the low group. With fewer cows to spread the labour costs over, the result is higher labour expenses per cow and therefore economies of scale again play a role in the profitability of the cow/calf enterprise.

These differences in individual parameters categorized under variable costs resulted in significant differences ($P<0.05$) in total variable costs on a per cow basis between the profit groups. The high, medium-high and medium-low groups averaged total variable costs that did not differ ($469.01, $457.68 and $555.56 per cow, respectively). The low profit group had a total variable cost of $748.42 per cow, which was significantly higher ($P<0.05$) than the other three profit groups. This increase in total variable costs begins to shed light as to why the low profit herds are not achieving higher profitability. High production costs have been identified as the key factor in determining profitability of the cow/calf enterprise (Sprott et al. 1998). Miller et al. (2001) concluded that cost factors were more influential than production, reproduction or producer controlled marketing factors in determining enterprise profitability. It was concluded that even with above average production, high cost producers are at a competitive disadvantage and therefore control of production costs is imperative.

The capital costs for the profitability groups are presented in Table 4.6. Capital costs are defined as those costs that do not change as output changes. No significant differences ($P>0.05$) were seen between the four profitability groups for share/lease payments, taxes/insurance/license or paid capital interest. However, the low profit group had a significantly higher average cost associated with equipment/building depreciation ($54.09 per cow) as compared to the high profitability group ($23.12 per cow). This is most likely a result of being able to spread the costs associated with depreciation of buildings and equipment over more cows for larger enterprises whereas small enterprises have fewer cows to spread these costs over. There were no differences in total capital costs between the four profit groups ($P>0.05$).

Total cost of production was calculated by combining both the total variable costs and the total capital costs. When total cost of production was compared across the four profit groups, significant differences were detected between the top three profit groups and the low profit group ($P<0.05$). Average cost of production for the high, medium-high and medium-low profit groups were $542.60, $511.48 and $613.72 per cow, respectively. The low profit group averaged a considerably higher cost of production of $842.06 on a per cow basis. This high cost of production is another key determinant as to why these low profit enterprises are not more profitable. With no significant difference detected between profit groups in capital costs, the most likely cost of production parameter that low profit enterprises need to consider when evaluating areas for improvement are the variable costs associated with producing the weaned calf.

Winter feed costs have been identified as a critical factor in dictating herd profitability (Miller et al. 2001). Producers need to closely monitor feed costs and ensure that they are minimizing the cost of feeding cows. This can be done through feed analysis, proper ration balancing and investigation of possible alternative feedstuffs, which may be more cost effective than traditional feedstuffs.

The effect of herd size on profitability may be a result of the likelihood that smaller cow/calf enterprises may not be the main enterprise or source of income for the farm and therefore may not get the same management time and attention as the larger enterprises. Often larger cow/calf enterprises are the main source of income for the farm family. Secondly, larger enterprises have more animals to spread the work over in comparison to the smaller herds. That is, it may take just as much work to feed 65 cows as it does to feed 165 cows. The question then becomes for smaller producers would it be more economical to consider maintaining a larger cow herd or to eliminate the cow/calf enterprise all together?

The value that producers are receiving for the products they produce is also imperative to the financial success of the enterprise. Table 2.7 outlines the value received from the various products for each of the four profit groups. No significant differences ($P>0.05$) were seen in any one parameter between the four profit groups; however, there were some substantial differences that led to a significantly different ($P<0.05$) total value of production between the four profit groups. Value of weaned calves on a per cow basis varied from $459.28 for the low profit group to $664.39 for the high profit group. Also, bred cows and heifers ranged in value from $23.39 per cow for the low profit group to $135.53 for the high profit group. These differences in favour of the high profit group resulted in this group having the highest value of production with an average of $898.08 per cow. The medium-high and medium-low profit groups had significantly ($P<0.05$) less value for the enterprise's production with $715.33 and $634.82 per cow. Although not significantly different from the medium--low group, the low profit group had the lowest value of production with an average of $514.33 per cow. With this low value of production and the high cost of production mentioned earlier it is now quite easy to identify the reasons for these enterprises falling into the low profit group of producers. From this data set it can be stated that producers who do not achieve high profits are not maximizing the value received for their product, have high costs associated with winter feed, machine repairs and unpaid labour and have higher overall cost of production.

The four groups of producers were ranked according to profitability. When total profit numbers were analyzed statistically there were differences in total profit between the groups. Total profit was determined by subtracting the cost of production from the total value of production. This resulted in significant differences ($P<0.05$) in total profit between the high, medium-high, medium-low and low profit groups. Respective values were $355.48, $203.84, $21.10 and -$327.73 per cow. With a difference of over $600 per cow in average profit between the low and high profit groups, this reiterates the need for evaluation and explanation of the factors that have led to such drastic differences in overall profit of cow/calf enterprises.

From this analysis, conclusions can begin to be derived on the differences in key production and financial parameters that are indicative of profitable cow/calf enterprises. These results can reiterate to producers the importance of measuring these parameters and comparing their enterprise analysis with benchmark values from profitable enterprises.

Conclusions and Implications

Production parameters did not differ ($P>0.05$) between the four profit groups and therefore do not seem to be the determining variables in overall herd profitability. All groups seem to be achieving the same levels of production which suggests that cow/calf producers have learned to effectively manage the production parameters of the enterprise however, more emphasis needs to be placed on managing the financial aspects of the enterprise. The average number of cows wintered or herd size was significantly larger ($P<0.05$) for the high profit group (164.4) than the low profit group (65.4). This suggests that larger herds tend to be more profitable and that economies of size play a role in the profitability of the cow/calf enterprise. That is not to say that smaller herds can not be profitable, however, on average larger herds are often the more profitable herds (Langemeier et al. 1995).

The financial parameters measured did differ significantly between the four profit groups and likely are the variables that producers should be measuring and evaluating more closely in order to improve the cow/calf enterprises' profitability. The results suggest that variable costs are an area that should be more closely monitored and could be better managed in an attempt to improve profitability. Significant differences began to arise between the four profit groups when winter feed, machinery repairs and unpaid labour were considered. Unpaid labour was over twice as high for the low profit group ($131.02 per cow) as the average for the high profit group ($54.65 per cow). As discussed earlier, this may be explained by the consideration that the larger herds have more cows to spread the labour over and it may require almost as much labour to feed a small cow herd as a large herd. This resulted in the low profit group ($748.42 per cow) having almost 40% higher total variable costs than the high profit group ($469.10 per cow). These significantly higher variable costs are one area that low profit producers should be examining in order to achieve a high profit enterprise.

Although not significant ($P>0.05$), capital costs were higher for the low profit herds ($93.64 per cow) when compared to the average capital costs of the high profit group ($73.50 per cow). This difference contributed to a much higher total cost of production for the low profit group ($842.06 per cow) than the high profit group ($542.50 per cow). These results indicate that producers should be closely monitoring their cost of

production and may be able to improve profitability by first understanding and then decreasing the costs associated with production. Results such as these may serve as benchmarks for producers who want to fully understand where their enterprise ranks in terms of cost of production and what they should realistically be aiming to achieve.

Value of production was also significantly different between the four herds ($P<0.05$) indicating that these are also important financial parameters to consider in terms of enterprise profitability. Producers who maximize the income they generate from their products obviously are more likely to be profitable. In terms of value of production, high profit herds averaged $848.98 per cow in comparison to low profit herds that averaged only $514.33 per cow. This is likely a result of producers in the high profit groups paying closer attention to marketing their product and examining all their options in order to maximize the value they receive for the product. For example, things such as marketing directly to the backgrounder or feedlot or paying close attention to markets so as to ensure calves are sold at the highest possible price. This difference, in addition to the higher cost of production explains why the low profit herds are not achieving a higher level of profitability.

These results indicate that financial parameters are the key factors influencing the profitability of the cow/calf enterprise. Production parameters did not differ between groups when enterprises are ranked according to profitability. However, variable costs, specifically unpaid labour and winter feed costs, along with value of production were the key differences between the low and high profit groups. This suggests that all producers have achieved a high standard for production, but the variability between enterprises begins to exist when cost and value of production are considered. It is imperative for producers to understand that they cannot make improvements if they do not measure all components, including financial aspects, of the enterprise. Only once these components are measured can they begin to make profitable management decisions. These results can act as an extension tool that producers can use to better understand those factors that are influencing the profitability of their enterprise and to assist them in achieving a higher profit cow/calf enterprise.

Table 2.1. Breeding performance variables from nineteen cow/calf herds across Saskatchewan during 1998 and 1999 ranked according to profitability

Variable	Profitability				Pooled SEM
	Low	Medium-Low	Medium-High	High	
Cows wintered	65.4c	98.0bc	143.3ab	164.4a	18.7
Females exposed	66.3c	100.1bc	151.1ab	188.1a	21.8
Bred females purchased	1.6	10.0	13.7	6.4	6.6
Bred females sold	1.8	3.8	4.3	5.6	3.2
Open cows culled	4.8	6.5	5.6	11.7	3.2
Open cows kept	0.8	1.8	3.1	6.8	2.6
Bred Females	60.2b	98.1b	151.6a	167.3a	18.5
Length of breeding period (days)	157.3	203.8	129.6	139.0	44.01
Total conception rate (%)	92.8	92.8	95.4	89.4	2.26

a-c Means in the same row followed by different letters are significantly different ($P<0.05$)
SEM = Standard error of the mean

Table 2.2. Calving production variables from nineteen cow/calf herds across Saskatchewan during 1998 and 1999 ranked according to profitability

Variable	Profitability				Pooled SEM
	Low	Medium-Low	Medium-High	High	
Total cows/heifers calving	60.1c	98.1bc	141.7ab	166.9a	17.5
Sets of twins (%)	0.9	2.2	1.6	1.9	0.6
Calves born dead/aborted (%)	4.1	5.6	2.6	4.4	1.0
Total livebirths	58.7c	95.4bc	140.5ab	162.4a	17.3
Length of calving period (days)	114.0	108.6	89.7	132.8	14.5
Calves born in first two cycles (%)	46.2	69.9	70.8	58.3	9.9
Calving rate (%)	96.9	96.8	95.3	97.4	2.8

a-c Means in the same row followed by different letters are significantly different ($P<0.05$); SEM = Standard error of the mean

Table 2.3. Calving variables from nineteen cow/calf herds across Saskatchewan during 1998 and 1999 ranked according to profitability

Variable	Profitability				Pooled SEM
	Low	Medium-Low	Medium-High	High	
Caesarean sections (%)	0.7	0.4	1.4	1.7	1.0
Hard pulls (%)	2.0	1.5	4.7	4.9	2.6
Moderately assisted (%)	9.7	5.5	8.8	15.0	5.4
Unassisted births (%)	76.5	80.1	76.0	78.5	11.1

SEM = Standard error of the mean

Table 2.4. Birth to weaning production variables from nineteen cow/calf herds across Saskatchewan during 1998 and 1999 ranked according to profitability

Variable	Profitability				Pooled SEM
	Low	Medium-Low	Medium-High	High	
Livebirths	58.7c	95.4bc	140.5ab	162.4a	17.3
Calves lost at pasture - after 24hrs (%)	2.7	2.3	1.7	1.3	0.9
Baby calves purchased (%)	0.1	1.2	0.8	0.2	0.6
Baby calves sold (%)	0.9	0.3	0.3	1.6	0.7
Weaning rate (%)	96.2	98.6	98.8	97.5	1.3
Total calves weaned	56.6c	93.5bc	139.4ab	158.8a	17.3
Weaning wt – steers (kgs)	254.4	264.7	261.9	267.3	14.3
Weaning wt – heifers (kgs)	248.8	250.0	244.6	253.8	11.5
Weight per day of age (kgs)	0.9	1.0	1.2	1.1	0.1
Kgs weaned/female exposed (kgs/cow)	219.5	225.1	229.8	223.3	16.4

a-c Means in the same row followed by different letters are significantly different ($P<0.05$); SEM = Standard error of the mean

Table 2.5. Variable costs on a per cow basis from nineteen cow/calf herds across Saskatchewan during 1998 and 1999 ranked according to profitability

Variables	Profitability				Pooled SEM
	Low	Medium-Low	Medium-High	High	
Winter feed ($/cow)	240.89a	182.45b	148.02b	117.39b	20.10
Bedding ($/cow)	30.26	22.25	25.76	31.75	7.01
Pasture ($/cow)	123.56	113.45	110.84	146.36	15.34
Vet & medicine ($/cow)	29.77	25.06	18.01	19.49	4.59
Breeding fees ($/cow)	1.51	0.00	7.70	3.00	2.77
Trucking & marketing ($/cow)	26.23	17.23	11.84	7.25	5.92
Fuel ($/cow)	26.38	24.23	13.44	16.27	4.73
Machine repairs ($/cow)	35.64a	10.28b	14.50b	10.41b	5.34
Building repairs ($/cow)	8.10	12.18	5.73	4.81	2.87
Utilities ($/cow)	39.89	37.00	31.20	24.73	9.49
Custom work ($/cow)	26.66	24.40	11.17	3.15	7.01
Operating interest ($/cow)	28.34	6.71	2.33	7.05	11.85
Paid labour ($/cow)	0.17	6.27	2.48	7.96	4.21
Unpaid labour ($/cow)	131.02a	74.06ab	69.51ab	54.65b	17.85
Total Variable Costs ($/cow)	748.42a	555.56b	457.68b	469.10b	44.02

a-b Means in the same row followed by different letters are significantly different ($P<0.05$)
SEM = Standard error of the mean

Table 2.6. Capital costs on per cow basis from nineteen cow/calf herds across Saskatchewan during 1998 and 1999 ranked according to profitability

Variable	Profitability				Pooled SEM
	Low	Medium-Low	Medium-High	High	
Share/lease payments ($/cow)	12.99	5.74	0.00	23.02	7.70
Taxes/insurance/license ($/cow)	10.78	5.29	2.77	5.72	2.29
Equip./building depreciation ($/cow)	54.09a	39.35ab	29.11b	23.12b	6.08
Paid capital interest ($/cow)	15.77	7.78	21.93	21.63	8.23
Total Capital Costs ($/cow)	93.64	58.16	53.81	73.50	10.95
Total cost of production ($/cow)[Z]	842.06a	613.72b	511.48b	542.60b	44.80

a-b Means in the same row followed by different letters are significantly different ($P<0.05$)
SEM = Standard error of the mean
[Z] Total cost of production = Total variable costs + Total capital costs

Table 2.7. Value of Production on a per cow basis from nineteen cow/calf herds across Saskatchewan during 1998 and 1999 ranked according to profitability

Variable	Profitability				Pooled SEM
	Low	Medium-Low	Medium-High	High	
Total weaned calves ($/cow)	459.28	561.05	601.68	664.39	56.31
Feeders ($/cow)	32.62	0.00	0.00	1.60	13.00
Cull cows/open heifers ($/cow)	111.98	85.21	63.16	116.61	31.27
Bulls ($/cow)	28.11	18.45	15.56	13.61	7.41
Bred cows/bred heifers ($/cow)	23.39	20.62	27.66	135.53	31.21
Miscellaneous ($/cow)	3.85	2.17	1.72	5.79	1.97
Government programs ($/cow)	7.75	8.88	11.85	6.23	6.95
Inventory adjustment ($/cow)	197.00	214.70	136.70	335.20	103.29
Cattle purchases ($/cow)	349.60	276.30	143.00	380.90	96.39
Total value of production ($/cow)	514.33c	634.82bc	715.33b	898.08a	55.47
Total Profit ($/cow)	-327.73d	21.10c	203.84b	355.48a	38.37

a-d Means in the same row followed by different letters are significantly different ($P<0.05$)
SEM = Standard error of the mean

Study Area 3

Comparison of Two Radio Frequency Identification System for Use in Birth to Slaughter Information Programs

Introduction

Information management systems for cow-calf operators are being developed in response to changes regarding the marketing of cattle in North America such as branded products, grid marketing and retained ownership. By tracking animals from birth through to slaughter, useful information can be collected on an individual animal basis and can assist producers in making informed management decisions in an attempt to improve or maintain the profitability of the enterprise. In order to take advantage of these opportunities, it is necessary that producers be able to identify each animal uniquely and utilize a system that is quick and efficient with respect to transferring information between all sectors involved in beef production. Radio frequency identification (RFID) systems can offer producers the technology needed in order to receive information throughout the production cycle on each animal (Basarab et al. 1997).

Recent technological advances with respect to radio frequency animal identification systems have made quick and efficient individual identification of beef cattle a reality. As well, increasing concerns regarding animal health, food safety and the maintenance of Canada's beef export markets has forced individual animal identification into the forefront of the beef industry (McAllister et al. 2000). The Allflex™ RFID eartag (Allflex USA, Inc., Dallas, Texas) offers a unique, tamper-proof animal identification system. Previous research has been done with Allflex™ RFID button eartags with Basarab et al. (1997) finding the initial failure rate to be between 0.12% and 0.24% when scanned at tagging with a handheld reader. A dropout rate of 0.0% was determined with 4,186 animals tagged. Basarab et al. (1997) concluded that the Allflex™ RFID system achieved a level of reading accuracy and retention that would allow for use within a feedlot. It was noted that problems were encountered within the slaughter plant and these problems had to be addressed if RFID systems are to be successful in the traceback of animals from the slaughter plant to the herd of origin.

The Destron Fearing™ RFID tag system (Destron Fearing Corp., South St. Paul, Minnesota) also offers unique animal identification that is tamper-proof. Little public information is available regarding the success rate of this identification system in a typical beef production setting.

As a result, a comparative trial of radio frequency identification systems was conducted. The trial utilized the Allflex™ RFID and the Destron Fearing™ RFID systems in an attempt to determine the success rate of these systems within the feedlot and slaughter plant sectors. The objectives were to: 1) determine the retention rate of the two RFID tag types; 2) determine the accuracy with which the tags are read both in a feedlot and slaughter plant setting; 3) determine the repeatability of the correct

identification of each RFID tag type, that is can the identification number be read successfully throughout the trial.

Materials and Methods

Data Collection

Two trials were conducted using a total of 707 animals from various genetic backgrounds and sources. Cattle arrived at the University of Saskatchewan's Beef Research Station during November, 2000. Each animal was individually identified with a visual plastic tag in the left ear and one of the two RFID tags in the right ear. At time of tagging, all RFID tag numbers were cross-referenced with the visual identification tag number in order to ensure that animals were correctly identified during subsequent scanning attempts. The RFID tag was read at processing by a handheld reader in order to determine the initial failure rate. Each tagging system was scanned using the appropriate handheld scanner recommended by the respective tag company (Figure 3.1 and Figure 3.2). Tags were scanned while animals were going through the handling system in order to ensure that the identification systems have practical application within the feedlot.

Scanners were positioned 15 centimeters from the right side of the animal at a height level with the RFID tag in the animal's ear. Each scan was five seconds in duration. Three attempts were made to attain a successful scan of the tag. If the scanner did not successfully read the RFID tag after three attempts a "no read" was recorded for that tag.

In the first trial, 419 of these animals were backgrounded at the University of Saskatchewan's Beef Research Station using a standard 125-day backgrounding program that took the animals from 270 to 360 kilograms. Animals were randomly assigned to 12 pens with 33 animals per pen. The animals in six of the pens were tagged with the Allflex™ RFID tag and the animals in the other six pens with the Destron Fearing™ RFID tag. All animals had a standard plastic visual tag as a control. Upon the completion of backgrounding, the animals were moved to a commercial feedlot (Pound-Maker Agventures, Ltd. Lanigan, SK) for finishing. While at the University of Saskatchewan Beef Research Station, the animals were weighed every two weeks and their identification tags scanned at this time. The tags were scanned at the research station prior to animals being sent to the commercial feedlot.

In the second trial, 288 animals were fed to finish at the University of Saskatchewan's Beef Research Station. These animals were randomly assigned to 24 pens with 12 animals in each pen. As with the backgrounded animals, the animals in 12 of the pens were tagged with the Allflex™ RFID tag and the animals in the other 12 pens were tagged with the Destron Fearing™ RFID tag and a standard plastic visual tag was placed in all animals as a control. These animals were also weighed every two weeks throughout the feeding period and the RFID tags scanned at this time. Prior to the animals leaving the research station for slaughter, the RFID tags were scanned.

All animals were slaughtered at the XL Beef Plant in Moose Jaw, Saskatchewan. RFID tags were read within the plant subsequent to stunning using the Anitech Information Systems' DT-500 Data Collection System (Anitech Enterprises Inc., Markham, Ontario). RFID tags were removed following scanning and identification

numbers along with visual tag identification numbers recorded in order to ensure correct identification by the scanner within the plant. Print outs of the individual animal identification for each lot were obtained from the plant's computer system and cross-referenced with previously recorded RFID numbers to verify each scan.

Statistical Analysis

The data collected was analyzed using chi-square analysis in order to establish differences in percentages of correct RFID tag scans and retention rates between the identification systems both within the feedlot and at time of slaughter within the slaughter plant.

Results and Discussion

Trial 1

Identification tags were scanned 6 times while in the University of Saskatchewan's Beef Research Station, prior to leaving the research station for the commercial feedlot and finally within the slaughter plant subsequent to stunning. Percentages of correct scans for each identification system are reported in Table 3.1. There was no significant difference ($P>0.10$) between the two identification systems scanned while at the university research station with Allflex™ and Destron Fearing™ RFID systems achieving 99% and 100% correct scans respectively. Similarly, at the slaughter plant there was no difference ($P>0.10$) between the two systems in the percentage of correct scans. The Destron Fearing™ system had a 97% successful scan rate and the Allflex™ system had a 98% successful scan rate. This high percentage of successful scans would suggest that the two tag systems could provide an accurate source for tracking of beef animals within a backgrounding and commercial feedlot setting and as well, through to slaughter.

Retention rate of the two RFID tag systems reported in Table 3.3 was also very high and no significant difference ($P>0.10$) was detected between the two RFID systems. Retention rate was 99% and 100% for the Allflex™ and Destron Fearing™ RFID tag systems, respectively. There was a significant difference ($P<0.001$) in the retention of the RFID tags as compared to the visual identification tags (Table 5.4). This suggests that the two RFID tag systems are just as effective or better than the identification method that is currently serving as the industry standard for animal identification.

Trial 2

Results from the two RFID tag systems are shown in Table 32. Both RFID tag systems reported an average successful scan rate of higher than 99% across the 15 scan dates and the end of test scan prior to being transported to the slaughter plant. There was no significant difference ($P>0.10$) between the percentages of correct scans for the two RFID tag systems at the slaughter plant. Allflex™ and Deston Fearing™ tag systems achieved a 98 and 96% correct scans, respectively. This again suggests that both RFID systems would provide an accurate means for cattle identification from backgrounding through to slaughter.

Retention rate of the two RFID tag systems for both areas of the study are reported in Table 3.3. Both tag systems attained 100% retention rate while at the

research station and through to slaughter. No difference ($P>0.100$) was detected in retention between the RFID and visual identification tags in this trial (Table 3.4). The results of the comparison of the RFID and visual identification tag from both trials provides further validity to the suggestion that both RFID button tag systems can provide the technology required for reliable identification of beef animals throughout the production period.

5.4 Conclusions and Implications

The results from this study suggest that radio frequency identification systems can provide an accurate and reliable means of identifying beef animals throughout the production cycle. Percentage of correct scans for both RFID tag systems was extremely high for both trials and therefore indicates that these systems can provide an accurate means of individually identifying beef cattle within the feedlot and through to slaughter. Both the Allflex™ and Destron Fearing™ RFID tag systems averaged a successful scan rate higher than 99% (Table 3.1 and Table 3.2) when scanned at the beef research station. Within the slaughter plant, Allflex™ RFID tags were correctly scanned 98% of the attempts for both trials. Destron Fearing™ RFID tags scanned correctly 97% for the commercial feedlot trial and scanned correctly 96% of the attempts for the animals finished at the beef research station. These high success rates for identification of animals within a slaughter plant subsequent to stunning demonstrates that both RFID tag systems can provide successful identification of beef animals within a slaughter plant setting. This further suggests that these RFID tag systems can provide the accurate individual tracking of animals that is required for the implementation of birth to slaughter identification programs currently of interest within the beef industry. However, further research evaluating these identification systems from birth through to slaughter would be beneficial in determining the accuracy of individual identification of beef animals throughout the entire production chain.

Retention rates of both RFID tag systems (Table 3.3) indicates that these tagging systems can offer a reliable means of individual animal identification that is required for birth to slaughter management systems. Although there was no significant difference ($P>0.10$) in retention rates between the visual tags and the RFID tags in trial 2, there was a significant difference in retention rates ($P<0.001$) in trial 1. This suggests that both types of RFID tags are retained as well or better than the current industry standard identification tag system. These results support those of Basarab et al. (1997) who determined that RFID button tags had a high retention rate in the feedlot. Again, added research is required in order to evaluate the retention rate of RFID tag systems through all sectors of the beef production chain.

Allflex™ and Destron Fearing™ RFID tag systems can provide reliable and accurate identification of beef cattle and therefore should be considered as an alternative form of individual animal identification that can provide the reliability and accuracy required for birth to slaughter information programs that are of increasing interest to the beef industry.

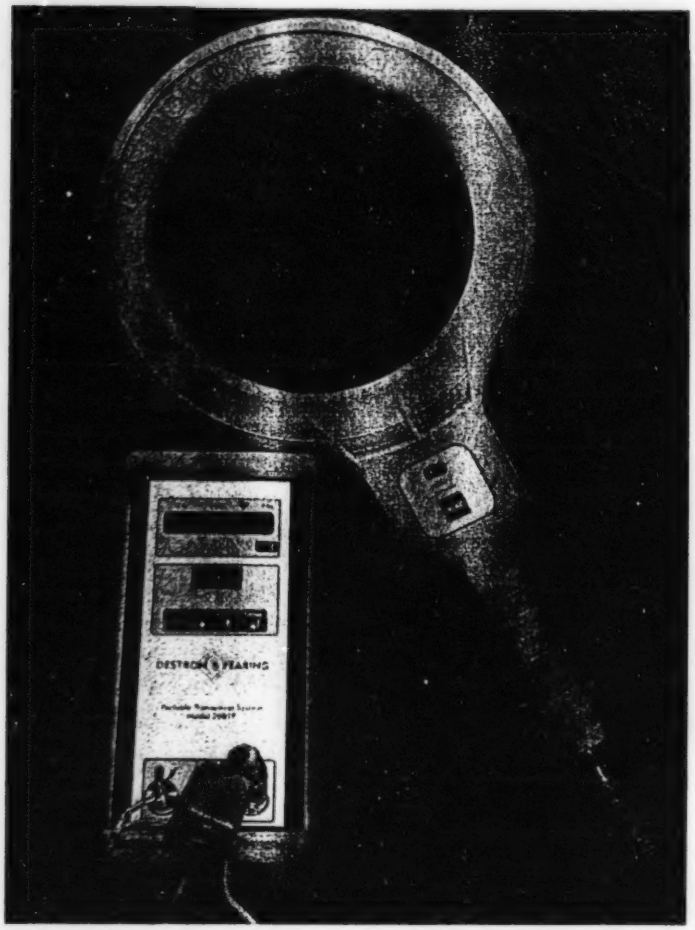

Figure 3.1. Destron Fearing Portable Transceiver system (Destron Fearing Corp., St. Paul, MN)

Figure 3.2. Psion Workabout scanner (Psion Industrial PLC, London, England)

Table 3.1. Percentage of correct scans for two radio frequency identification systems during backgrounding and within the slaughter plant subsequent to stunning for Trial 1

Date of Scan	Allflex™		Destron Fearing™		Chi-square value	p-value
	n	% correct	n	% correct		
14-Dec-00	190	99	186	99	0.000	>0.10
20-Dec-00	192	98	185	100	2.914	>0.10
3-Jan-01	192	99	182	99	0.001	>0.10
17-Jan-01	192	99	190	100	0.992	>0.10
31-Jan-01	192	99	190	100	0.992	>0.10
14-Feb-01	192	99	190	100	1.990	>0.10
19-Feb-01	192	99	190	100	0.992	>0.10
Slaughter plant[z]	190	98	190	97	1.024	>0.10

[z]Animals were slaughtered on July 3rd and 4th, 2001

Table 3.2. Percentage of correct scans for two radio frequency identification systems during backgrounding, finishing and within the slaughter plant subsequent to stunning for Trial 2

Date of Scan	Allflex™		Destron Fearing™		Chi-square value	p-value
	n	% correct	n	% correct		
13-Dec-00	144	99	139	100	0.969	>0.10
27-Dec-00	144	100	142	99	1.018	>0.10
10-Jan-01	144	100	139	100	-	-
23-Jan-01	144	100	142	99	1.018	>0.10
7-Feb-01	142	100	143	100	-	-
27-Feb-01	142	100	144	100	-	-
14-Mar-01	141	100	142	99	0.996	>0.10
28-Mar-01	141	100	144	100	-	-
11-Apr-01	141	100	144	100	-	-
25-Apr-01	141	100	143	100	-	-
9-May-01	133	100	139	100	-	-
23-May-01	104	100	97	100	-	-
7-Jun-01	56	100	37	100	-	-
21-Jun-01	25	100	12	100	-	-
5-Jul-01	25	100	12	100	-	-
End of test[Y]	140	100	144	100	-	-
Slaughter plant[Z]	140	98	144	96	0.947	>0.10

[Y]Eartags were scanned at the University of Saskatchewan Beef Research Station prior to animals being sent for slaughter
[Z]Animals were slaughtered between May 2nd and July 18th, 2001

Table 3.3. Percentage of RFID tags retained for two radio frequency identification systems from backgrounding through to time of slaughter during Trials 1 and 2

Trial	Allflex™		Destron Fearing™		Chi-square value	p-value
	n	% retained	n	% retained		
Trial 1[Y]	192	99	190	100	1.990	>0.10
Trial 2[Z]	140	100	144	100	-	-

[Y]Animals were backgrounded at the University feedlot and finished at PoundMaker Agventures Ltd
[Z]Animals remained at the University of Saskatchewan feedlot throughout the feeding period

Table 3.4. Comparison of retention rates of RFID button tags versus visual identification tags from backgrounding through to time of slaughter during Trials 1 and 2

Trial	RFID Tags		Visual Tags		Chi-square value	p-value
	n	% retained	n	% retained		
Trial 1[Y]	382	99	382	96	12.144	<0.001
Trial 2[Z]	284	100	284	99	1.002	>0.100

[Y]Animals were backgrounded at the University feedlot and finished at PoundMaker Agventures Ltd
[Z]Animals remained at the University of Saskatchewan feedlot throughout the feeding period

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